Linking Control Data with Basic Ecological Information to Improve the Removal Efficacy of the Invasive Cordgrass, *Spartina anglica*, in Puget Sound, Washington

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Abstract
The non-indigenous cordgrass, *Spartina anglica,* covers ~3,000 ha in Puget Sound, causing changes to invaded intertidal communities. A control program, begun in 1997, has caused a ~20% decline. We combine control data with basic ecological information and determine three main factors influencing control success. First, number of years and consistency of removal are critical. After four years, sites with consistent control (uninterrupted for 2 years) showed 86% (± 5%) decline, 2.5 times greater than those with intermittent removal (1 year missed; 32 ± 6%). This was true even though the number of years between control regimes varied by 1 year. Second, control success differed among habitat types. Low salinity marshes have smaller declines (13 ± 4%) compared to mudflats (38 ± 5%) and cobble beaches (34 ± 4%) while high salinity marshes show the best response (45 ± 5%). These differences probably originate from responses of both *S. anglica* and native competitors to different physical conditions rather than years of removal. Third, spatial scale is important; larger invasions (>10 ha) had a lower percent decline (39 ± 8%) than smaller (10 ha) invasions (66 ± 6%) suggesting that more extensive invasions show better re-growth.

Extended Abstract

The non-indigenous cordgrass, *Spartina anglica*, covers ~3,000 ha in Puget Sound, Washington, causing significant changes to invaded intertidal communities (Hacker et al. 2001). *Spartina anglica* invades four habitat types, including mudflats, cobble beaches, low salinity marshes and high salinity marshes, but is particularly extensive in mudflats and low salinity marshes (Hacker et al. 2001). A control program, which began in 1997, has caused a ~20% decline. Little is known about the causes of cordgrass decline or the potential for restoration of previously invaded habitat. To explore this in more detail, we combined information from control records with basic ecological information and newly collected data on cordgrass and native plant abundance. We determined that three main factors influence cordgrass control success and native habitat restoration.

First, number of years and consistency of removal are critical. After four years, sites with consistent control (uninterrupted for ≥ 2 years) showed 86% (± 5%) decline, 2.5 times greater than those with intermittent removal (≥ 1 year missed; 32 ± 6%). This was true even though the number of years between control regimes varied by ≤ 1 year. In addition, native plant cover increased three fold under consistent removal and continued to decline under intermittent removal.

Second, control success and restoration differed among habitat types. Low salinity marshes have smaller cordgrass declines (13 ± 4%) compared to mudflats (38 ± 5%) and cobble beaches (34 ± 4%) while high salinity marshes show the best response (45 ± 5%). Moreover, the only sites that showed a restorative response to cordgrass removal were the low salinity marshes. Other habitats continued to retain legacy effects of the invasion. These differences originate from the interactions between *S. anglica* and native plant species under different physical conditions rather than the amount of effort invested in removal.

Third, spatial scale is important; larger invasions (>10 ha) had a lower percent decline (39 ± 8%) than smaller (≤10 ha) invasions (66 ± 6%) suggesting that more extensive invasions exhibit proportionally lower cordgrass decline and potential for restoration.

We suggest that by combining readily available control data with simple ecological information that can be generated without years of research, or delaying active control efforts, it is possible to substantially improve the efficacy of current and future invasive species management programs.

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References

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